The natural history of autologous fistulas as first-time dialysis access in the KDOQI era

Andre Biuckians, MD, MPH, Eric C. Scott, MD, George H. Meier, MD, Jean M. Panneton, MD, and **Marc H. Glickman, MD,** *Norfolk, Va*

Background: **Patients on hemodialysis depend on durable, easily maintained vascular access. The autologous arteriovenous fistula (AVF) has been the gold standard since the introduction of the Brecia-Cimino fistula in 1966 and is echoed in the current Kidney Disease Outcomes and Quality Initiative (KDOQI) guidelines. The purpose of this study is to determine the natural history of AVF in patients requiring first-time permanent access in a large academic vascular surgery practice.**

Methods: **We performed a retrospective review of patients undergoing new access creation from January 1, 2005 to June 30, 2005. The study group consisted of patients with no prior permanent access that underwent AVF creation. Categorical data was compared using χ^2 analysis, nominal data was compared using Student t-test, and patency was determined by Kaplan-Meier curves.**

Results: **During the 6-month period, there were 80 first time AVF creations. The majority of patients were male (69%), African American (55%), and a history of diabetes (55%) and hypertension (96%). Seventy-five percent of patients were already undergoing hemodialysis via catheter access. Seventy-six percent of patients underwent preoperative vein mapping with a mean vein diameter of 3.1 mm. Twenty-six radiocephalic AVF (RCAVF) and 54 brachiocephalic AVF (BCAVF) were created with a mean follow-up of 278 days. At the end of follow-up, 38 (48%) AVF were being used for hemodialysis and only nine (11%) matured without the need for additional intervention. Mean time for AVF maturation was 146 days. Thirty AVF (37%) were abandoned, 16 (20%) of which were primary failures. Mean time to abandonment was 162 days. Twelve (15%) AVF remained patent but were never cannulated. The intervention rate was 1.33 interventions/patient/year and 75% of interventions were percutaneous. Kaplan-Meier analysis determined primary, primary-assisted, and secondary patency was 36% ± 8.3, 55% ± 6.5, and 55% ± 6.5 at 1 year, respectively. Cumulative functional patency was 63% at 1 year.**

Conclusions: **In patients receiving a first time permanent access, we found that the majority were AVF and they resulted in low primary patency rates at 1 year and long maturation times. KDOQI encourages AVF creation in order to increase AVF use for dialysis, but the strategy of simply increasing the number being created may not lead to the desired result and potentially lead to an increase in catheter dependence. (J Vasc Surg 2008;47:415-21.)**

Effective and durable permanent hemodialysis access has been the goal of access surgeons since the introduction of the Scibner shunt in 1960[1] and Brescia-Cimino fistula in 1966.[2] The National Kidney Foundation (NFK) began the Dialysis Outcomes and Quality Initiative (DOQI) in 1995, now referred to as the Kidney Disease Outcomes and Quality Initiative (KDOQI), which published a large evidence-based set of clinical guidelines to help improve healthcare outcomes among patients with end stage renal disease (ESRD). One major focus of KDOQI is optimal arteriovenous (AV) access management, which has lead to the creation of the National Vascular Access Improvement Initiative (NAVII) and its Fistula First campaign.[3]

KDOQI makes it clear that all patients with stage IV or stage V chronic kidney disease (CKD) who opt for hemodialysis should undergo autologous fistula creation. In order to preserve viable access sites, they recommend a radiocephalic arteriovenous fistula (RCAVF) as the first and best option. If not feasible, then a brachiocephalic arteriovenous fistula (BCAVF), followed by a basilic vein transposition (BVT) should be created in the non-dominant arm. Prosthetic arteriovenous bridge grafts (AVG) and tunneled dialysis catheters are mentioned as last resorts in patients with no autologous options. These recommendations are based upon available data that suggests that AVF have superior patency, fewer complications, require fewer re-interventions, and ultimately improve patient survival.[3]

Since the inception of KDOQI, there has been a significant increase in AVF creation[4] and a goal of 65% prevalence of AVF utilization for hemodialysis by 2009 is set forth in the most recent KDOQI revision.[3] With the increased number of AVF creations, a measurable reduction in morbidity and mortality was anticipated. However, published data from the United States Renal Data System (USRDS) reported that the number of hospital admissions for AV access infections has continued to increase every year and mortality has remained unchanged.[5] This study was undertaken to determine the natural history of AVF created in a large, experienced academic vascular surgery practice performing approximately 750 new access procedures per year.

From the Division of Vascular Surgery, Eastern Virginia Medical School and Vascular and Transplant Specialists.

Competition of interest: none.

Presented at the Thirty-first Annual Meeting of the Southern Association for Vascular Surgery, Rio Grande, Puerto Rico, Jan 17-20, 2007.

Reprint requests: Andre Biuckians, MD, MPH, Eastern Virginia Medical School, Department of Surgery, 600 Gresham Drive, Suite 8620, Norfolk, VA 23507 USA (e-mail: abiuckians@gmail.com).

0741-5214/$34.00

doi:10.1016/j.jvs.2007.10.041

METHODS

After obtaining approval from the Eastern Virginia Medical School Institutional Review Board, we used the CPT codes 36818, 36819, 36820, 36821, and 36825 to query the practice's billing database and generate a list of patients who underwent AV access surgery between January 1, 2005 and July 30, 2005. Only first-time AVF creations were included in the review. Patients who received a prosthetic AV bridge graft or had undergone prior AV access surgery were excluded from the analysis. The presence of a temporary or cuffed dialysis catheter was not a cause for exclusion.

The office and hospital charts were reviewed for patient demographics, pertinent medical history, physical exam findings, preoperative imaging studies, and findings from the postoperative follow-up. Operative notes were reviewed for relevant procedural findings and complications. All postoperative interventions were reviewed for indication, procedure type, and outcome. The information was de-identified and recorded in a password protected database.

All preoperative evaluations, procedures, postoperative evaluations, and interventions were performed by one of the 14 board-certified vascular surgeons or the one board-certified transplant surgeon in the practice. AVF creation was the preferred procedure for first time access patients, but there was no standard selection algorithm used by the surgeons in the practice. Patients were screened for creation of a RCAVF, BCAVF, or BVT, though no one received a BVT in this cohort. Forearm BVT or proximal radial artery AVF are not routinely utilized by the practice.

Patients were initially seen during an outpatient visit and examined for vein adequacy. If a patient appeared to have adequate venous anatomy on examination, they were scheduled for AVF creation and at the time of the procedure, the venous anatomy was re-assessed by passing dilators proximally via the veinotomy. If the vein segment did not accommodate at least a 3 mm dilator, then another vein segment was explored or an AVG creation was performed. If the venous anatomy appeared inadequate on the in office examination, then preoperative vein mapping was performed in either the hospital or office noninvasive laboratory, both of which are Intersocietal Commission for the Accreditation of Vascular Laboratories (ICAVAL) certified. Vein mapping was performed in the supine position with the head of the bed at a 30-degree incline without the use of a tourniquet or warm soaks. Each vein segment was measured at multiple points along its length. Vein mapping results were reviewed by the operating surgeon and used at their discretion when deciding the type of access to be created.

All initial operations were performed in the operating room, and anastomoses were fashioned either with a running nonabsorbable suture, or in an interrupted manner with self-closing metal clips (U-CLIP, Medtronic, Minneapolis, Minn). Postoperative interventions took place in one of three venues: an operating room, a hospital-based endovascular suite, or an office-based endovascular suite.

A functional AVF was defined as a fistula being used for at least one successful hemodialysis treatment, and a patent AVF was defined as having a palpable thrill or a bruit on auscultation. An AVF was considered abandoned if it required a major revision, including creation of a new anastomosis or placement of a jump graft, required ligation, or if a new access was required at a new site. An AVF requiring a patch angioplasty revision was not considered abandoned. Postoperative interventions were categorized as open or percutaneous, and included balloon angioplasty, mechanical thrombectomy, stent deployment, vein branch ligation or embolization, and patch angioplasty with either an autologous or prosthetic patch.

The primary endpoints included AVF abandonment, renal transplantation, death, or the time measurement of patency. Primary patency was defined as the interval from AVF creation until abandonment, intervention, or the time of measurement of patency as recommended in the standards for reporting by Sidawy et al.[6] Primary-assisted patency was defined as the interval from AVF creation until thrombosis, abandonment, or the time of measurement of patency, including the time after interventions performed on a patent AVF.[6] Secondary patency was defined as the interval from AVF creation until abandonment or the time of measurement of patency, including the time after all interventions.[6] The cumulative functional patency was defined as the interval from when the AVF was cannulated until abandonment or the time of measurement of patency, including the time after any intervention to maintain or reestablish function. Primary failure was defined as abandonment of an AVF without ever being cannulated or intervened upon. The data was analyzed using MedCalc (Mariakerke, Belgium) statistical software. Categorical data was compared using χ^2 analysis, nominal data was compared using Student t test, and $P < .05$ was considered statistically significant. Kaplan-Meier survival curves were used to determine the patency of AVF and log rank testing was used to compare curves.

RESULTS

Demographics. A total of 377 patients underwent AV access creation from January 1, 2005 through June 30, 2005 and patient selection is depicted in Fig 1. Demographics of the study group are listed in Table I. At the time of AVF creation, 78% of patients were being dialyzed with a cuffed or noncuffed central venous catheter, and this was located on the contralateral upper body in 71% of patients. Preoperative vein mapping was performed in 76% of patients and the mean vein diameters were determined for the vein segments used for fistula creation (Table II). Biphasic arterial waveforms were documented on upper extremity arterial duplex examination performed at the time of vein mapping in all arteries chosen for fistula creation. Upper extremity artery diameters were not measured.

Operative data. Of 119 first-time access patients, 80 received an AVF and 39 received an AVG. The outcomes of

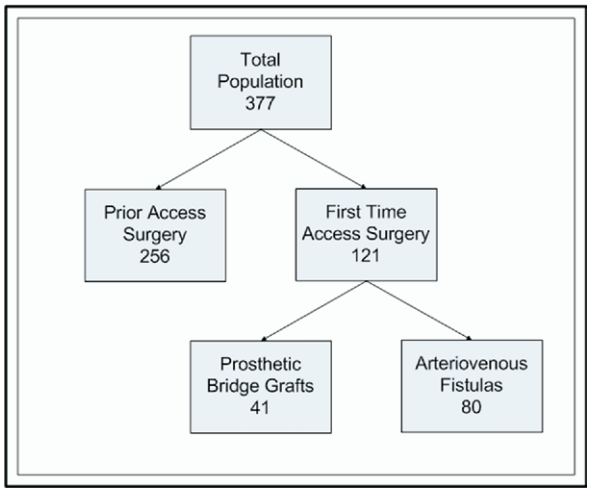

Fig 1. Stratification of all patients who underwent hemodialysis access surgery from January 1, 2005 to June 30, 2005. Only the patients who underwent autologous arteriovenous fistula creation as a first time access procedure were fully reviewed (n = 80).

Table I. Patient demographics and clinical characteristics of 80 patients undergoing first-time AVF creation

*Variable**	*No of patients (%)*
Total patient number	80 (100)
Gender	
Male sex	55 (69)
Ethnicity	
Caucasian	31 (39)
African American	44 (55)
Hispanic	2 (2.5)
Asian/Pacific Islander	3 (3.5)
Comorbidities	
Diabetes	44 (55)
Hypertension	77 (96)
Tobacco use	25 (31)
ESRD on dialysis	60 (75)

AVF, Autologous arteriovenous fistula; ESRD, end stage renal disease.
*Mean patient age, 59.7 y.

the AVG are not available for this report. There were 26 RCAVF (33%) and 54 BCAVF (67%) created over the 6-month period. RCAVF were created in 40% of male patients and 16% of female patients ($P = .06$). BCAVF were created in 60% of males and 84% of females (P = NS). Construction of the anastomosis was performed using a continuous nonabsorbable suture in 66% of cases and self-closing metal clips in the remainder. All 14 surgeons participated in access creation operations with an average of 5.3 ± 2.8 procedures per surgeon in this cohort during the 6-month period of study. Every surgeon in the group has at least 5 years of postfellowship practice experience with the majority having 10 years of experience or greater.

Follow-up. The mean follow-up was 278 days and ranged from 13 to 570 days. Outcomes were categorized as functioning, abandoned, and indeterminate as defined in the methods section. Thirty-eight AVF (48%) were functional at the end of follow-up and included 12 RCAVF (32%) and 26 BCAVF (68%), which meant that the AVF was the being successfully used for hemodialysis treatments. In the functional cohort, nine patients (11%) required no intervention to achieve and maintain function of the AVF, whereas 29 (36%) patients required at least one intervention. The overall mean time to first cannulation was 146 days, and the mean time to first cannulation was significantly shorter in patients with a BCAVF (129 days) compared with 187 days for RCAVF ($P = .03$). There was no statistical difference in length of time to the first cannulation if a patient required precannulation intervention.

Thirty AVF (37%) were abandoned 16 (20%) had primary failures, four (5%) failed after intervention but were never cannulated, and 10 (12.5%) functioned for prior to abandonment. The mean time to abandonment was 162 days for primary failure and 266 days for all other failures. The reasons for abandonment are listed in Table III. Abandoned AVF tended to have smaller mean vein diameters when compared with functional AVF, but this did not reach statistical significance (2.8 mm versus 3.3 mm, respectively, $P = .07$). The majority of abandoned AVF were BCAVF (60%), but this was not statistically significant. Twelve AVF (15%) were patent on the last documented physical exam but had never been cannulated and were considered indeterminate. Of these, four patients remained free from hemodialysis, five patients died, one patient underwent renal transplantation, and two patients continued hemodialysis via a dialysis catheter for unclear reasons.

Forty-five patients underwent a total of 81 interventions during the follow-up period, 75% of which were percutaneous and the intervention rate was 1.33 interventions per patient year. The types of interventions are listed

Table II. Reasons for abandonment of AVF created in patients who had never had prior permanent access

Reason for abandonment	*Number**
Inadequate dialysis	4
Poor maturation	10
Thrombosis	15
Procedural complication	1

AVF, Autologous arteriovenous fistula.
*Total number of abandoned AVF = 30.

Table III. Reasons for abandonment of AVF created in patients who had never had prior permanent access

Reason for abandonment	*Number**
Inadequate dialysis	4
Poor maturation	10
Thrombosis	15
Procedural complication	1

AVF, Autologous arteriovenous fistula.
*Total number of abandoned AVF = 30.

Table IV. Intervention performed on patients with a first time AVF stratified by type and number performed

Type of intervention	n
Percutaneous	
Diagnostic fistulogram alone	17
Balloon angioplasty	41
Coiling of branch vein	4
Open	
Distal revascularization interval ligation	1
Ligation of branch vein	7
Open thrombectomy	2
Patch angioplasty	4
Superficialization of vein	3

There were a total of 81 interventions performed in 45 patients.

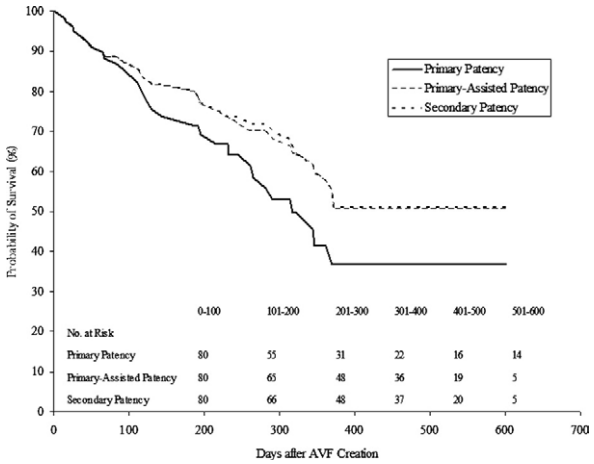

Fig 2. Kaplan-Meier survival curves of patients who underwent creation of an autologous arteriovenous fistula (AVF) for a first time access surgery. Note that the primary-assisted and secondary patency curves are not significantly different.

in Table IV. At 1 year, the primary patency, primary-assisted patency, and secondary patency were 36% ± 8.3, 55% ± 6.5, and 55% ± 6.5, respectively (Fig 2). The cumulative functional patency, where patency begins at the time of first successful cannulation, was 63% ± 7 at 1 year (n = 55), with no difference between the RCAVF and the BCAVF groups.

DISCUSSION

In 1997, the National Kidney Foundation published the first version of the KDOQI guidelines, which was meant to decrease practice variations among hemodialysis units in the United States and improve patient care. Vascular access management was one of four original topics, and it recommended the use of AVF in all hemodialysis dependent patients. The most current version of the KDOQI guidelines puts forth a goal of 65% prevalence of AVF use in the hemodialysis units in the United States by 2009. Since introduction of KDOQI, vascular access surgeons have increased the number of AVF being created.[4,7,8] It is assumed that this will increase the portion of AVF in use, yet this result has not yet been reported and its impact on morbidity and mortality remains to be seen.

This review focuses on patients presenting for a first-time access creation and characterizes the natural history of first-time AVF and the majority (66%) of first-ever access creations in our experience were autologous fistulas. The portion of AVF that were RCAVF was lower than that of BCAVF and is similar to the findings of Berman et al.[9] This is likely due to the fact that a decreased number of female patients receive a RCAVF and, as published elsewhere, is believed to be due to the smaller vessel diameters often found in female patients.[9-12] The overall lower number of RCAVF being created may also explain the lower number of functional RCAVF compared with BCAVF at the end of the follow-up period. No basilic vein transpositions were performed in this patient population, but it is considered an option by the surgeons in the practice. Basilic vein transpositions were certainly a second option when the initial AVF was abandoned.

Our mean vein diameter of 3.1 mm was an acceptable size for AVF creation. Silva et al recommended a vein diameter of at least 2.5 mm for adequate AVF creation and reported a 1-year cumulative AVF patency of 83%.[8] Mendes et al reported that only 16% of AVF created with a vein of less than 2 mm matured compared with 76% of AVF created with a vein of >2 mm.[13] Rooijens et al reported a 1-year primary patency of 33% in RCAVF constructed with vein less than 1.6 mm in diameter.[14] We did identify a trend of failure when AVF were created with smaller mean vein diameters in abandoned fistulas, but this did not reach statistical significance perhaps due to our small sample size.

Our AVF primary failure rate was 20% and a majority of failures were due to thrombosis that is similar to other published reports.[15,16] Our 1-year primary patency was lower than the primary patency rates reported in the literature, which ranged from 55% to 78%.[9,10,16-20] However, our 1-year primary-assisted patency and secondary patency were comparable with the 1-year secondary patencies in the literature, which ranged from 54% to 71%.[10,16,21] Our primary-assisted and secondary patencies were identical because only three AVF were salvaged after thrombosis and the majority patients with a thrombosed AVF received new access at a new site. The improved primary-assisted and secondary patency indicates salvage was possible, but a total of 83 interventions were performed to gain this modest increase.

The reason for the low primary patency seen in our cohort compared with the literature might be explained by an aggressive approach to creating autologous fistulas. As previously mentioned, our mean vein diameter was 3.1 mm, but patients had an AVF creation with a vein diameter as small as 1.3 mm. This may have increased our AVF creation rate to match the KDOQI prevalence goals, but using smaller vein diameters increases the failure rate.

Relying on traditional patency does not take into account the functional status of the fistula and overestimates the number of "working" fistulas at 1 year. We had several

patients who had patent fistulas that were not being use or others whose AVF required more than a year to mature, yet they are included as "working" in a Kaplan-Meier tabulation. The cumulative functional patency removes primary failures and time to maturation from the patency calculation. Our 1-year cumulative functional patency was 63% and demonstrates that even if an AVF was successfully used for hemodialysis, only two-thirds were functioning after 1 year. This may seem acceptable in regards to the KDOQI standards, but over half of the AVF never achieved a functional status.

Our AVF were cannulated in an average of 148 days, which is substantially longer than other published reports. Rayner et al reviewed the results from the Dialysis Outcomes and Practice Patterns Study (DOPPS) and found a median cannulation time for AVF of 98 days in the United States.[22] Allon et al reported an average cannulation time 87 days for AVF versus 18 days for AVG ($P < .001$).[23] In addition, our findings show that mean time to primary failure for our cohort was 162 days. Our prolonged time to cannulation was not expected and might be initially explained by AVF creation being performed in patients who have inadequate anatomy. However, if this was the case, then AVF with inadequate anatomy would be expected to fail rather than take longer to mature.[14] This prolonged time to cannulation might be a result of our follow-up routine, which includes an initial 4-week postoperative visit for all patients to examine the AVF and the incisions, followed by 4- to 6-week intervals until deemed ready for use. Once deemed ready for use, the patient receives a written order to allow cannulation, which he/she takes to the dialysis center and the dialysis center staff will cannulate. There are several potential factors that might explain the long time interval till cannulation, but we do not have enough data to make a definitive statement.

These results suggest that patient selection criteria for AVF creation in our current practice may not be appropriate and our postoperative follow-up inadequate. New access algorithms are required for both the preoperative and postoperative evaluation of the hemodialysis dependent patient in order to optimize access use and minimize morbidity. Unfortunately, our study did not reveal any demographics or anatomical factors that might have better predicted AVF abandonment, except perhaps for vein size. On the other hand, there seems to be opportunity for improved postoperative management. The long time interval for abandonment suggests that rigorous follow-up is necessary with set time intervals to achieve maturation or consider abandonment. There is some literature to suggest regular screening duplex ultrasounds may improve patency in AVG,[24] but there have been no randomized controlled trials to examine routine duplex ultrasounds of AVF. Dialysis dependence continues to be a growing problem and more patients will become catheter dependent while we wait for AVF maturation. Referral for access creation 6 months prior to the start of hemodialysis is recommended in KDOQI[3], but this has not been a common experience in our practice and is an aspect of patient care that can be improved upon.

The majority of our patients present for access evaluation following institution of hemodialysis via indwelling catheters. AVF creation seems to sentence these patients to catheter dependence for an additional 5 months if not longer. We did not evaluate whether any morbidity or mortality was associated with the increased time of catheter dependence, but there are several published reports that have examined this issue. Lee et al reported a 50% incidence of catheter related bacteremia at 6 months.[25] Allon et al showed the relative risk of death was 3.43 over a 1 year interval when patients dialyze using a catheter compared with an autologous fistula.[26] Thus, any patient on dialysis who receives an AVF will remain catheter-dependent for significant time intervals and be exposed to greater risk.

CONCLUSIONS

A high AVF creation rate is possible in the KDOQI era, but this does not necessarily translate into high AVF utilization. First, we have demonstrated that if an AVF was successfully used for hemodialysis, it required an average of 5 months to cannulation. Second, even in the best of circumstances in which a patient is undergoing a first-time access procedure, many AVF failed and of those that function only two-thirds are working at the end of 1 year. Adherence to the KDOQI strategy may increase autologous fistula creation, but in our experience, this has not resulted in increase AVF utilization and rather prolonged catheter-dependence while awaiting maturation and additional procedures.

AUTHOR CONTRIBUTIONS

Conception and design: AB, MG, GM, ES, JP
Analysis and interpretation: AB, ES, MG, GM
Data collection: AB
Writing the article: AB
Critical revision of the article: AB, ES, MG, JP, GM
Final approval of the article: AB, ES, MG, JP
Statistical analysis: AB, ES
Obtained funding: MG
Overall responsibility: MG

REFERENCES

1. Scribner BH, Buri R, Caner JE, Hegstrom R, Burnell JM. The treatment of chronic uremia by means of intermittent hemodialysis: a preliminary report. Trans Am Soc Artif Intern Organs 1960;6:114-22.
2. Brescia MJ, Cimino JE, Appel K, Hurwich BJ. Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula. N Engl J Med 1966;275:1089-92.
3. National Kidney Foundation Kidney Disease Outcomes and Quality Initiative (K/DOQI), 2006 update. National Kidney Foundation, Inc., 2006. (Accessed at www.kidney.org.).
4. Ascher E, Gade P, Hingorani A, Mazzariol F, Gunduz Y, Fodera M, et al. Changes in the practice of angioaccess surgery: impact of dialysis outcome and quality initiative recommendations. J Vasc Surg 2000;31: 84-92.
5. USRDS 2006 Annual Report: Atlas of End-Stage Renal Disease in the United States. In: Health NIo, ed. National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2006.

6. Sidawy AN, Gray R, Besarab A, Henry M, Ascher E, Silva M Jr, et al. Recommended standards for reports dealing with arteriovenous hemodialysis accesses. J Vasc Surg 2002;35:603-10.
7. Robbin ML, Gallichio MH, Deierhoi MH, Young CJ, Weber TM, Allon M. US vascular mapping before hemodialysis access placement. Radiology 2000;217:83-8.
8. Silva MB, Jr, Hobson RW, 2nd, Pappas PJ, Jamil Z, Clifford AT, Goldberg MC, et al. A strategy for increasing use of autogenous hemodialysis access procedures: impact of preoperative noninvasive evaluation. J Vasc Surg 1998;27:302-7; discussion 307-8.
9. Berman SS, Gentile AT. Impact of secondary procedures in autogenous arteriovenous fistula maturation and maintenance. J Vasc Surg 2001; 34:866-71.
10. Dixon BS, Novak L, Fangman J. Hemodialysis vascular access survival: upper-arm native arteriovenous fistula. Am J Kidney Dis 2002;39:92-101.
11. Kalman PG, Pope M, Bhola C, Richardson R, Sniderman KW. A practical approach to vascular access for hemodialysis and predictors of success. J Vasc Surg 1999;30:727-33.
12. Miller CD, Robbin ML, Allon M. Gender differences in outcomes of arteriovenous fistulas in hemodialysis patients. Kidney Int 2003;63: 346-52.
13. Mendes RR, Farber MA, Marston WA, Dinwiddie LC, Keagy BA, Burnham SJ. Prediction of wrist arteriovenous fistula maturation with preoperative vein mapping with ultrasonography. J Vasc Surg 2002;36: 460-3.
14. Rooijens PP, Burgmans JP, Yo TI, Hop WC, de Smet AA, van den Dorpel MA, Fritschy WM, et al. Autogenous radial-cephalic or prosthetic brachial-antecubital forearm loop AVF in patients with compromised vessels? A randomized, multicenter study of the patency of primary hemodialysis access. J Vasc Surg 2005;42:481-6; discussion 487.
15. Prischl FC, Kirchgatterer A, Brandstatter E, Wallner M, Baldinger C, Roithinger FX, et al. Parameters of prognostic relevance to the patency of vascular access in hemodialysis patients. J Am Soc Nephrol 1995;6: 1613-8.
16. Rooijens PP, Tordoir JH, Stijnen T, Burgmans JP, Smet de AA, Yo TI. Radiocephalic wrist arteriovenous fistula for hemodialysis: meta-analysis indicates a high primary failure rate. Eur J Vasc Endovasc Surg 2004; 28:583-9.
17. Zeebregts C, van den Dungen J, Bolt A, Franssen C, Verhoeven E, van Schilfgaarde R. Factors predictive of failure of Brescia-Cimino arteriovenous fistulas. Eur J Surg-Acta Chirurgica 2002;168:29-36.
18. Palder SB, Kirkman RL, Whittemore AD, Hakim RM, Lazarus JM, Tilney NL. Vascular access for hemodialysis. Patency rates and results of revision. Ann Surg 1985;202:235-9.
19. Livingston CK, Potts JR, 3rd. Upper arm arteriovenous fistulas as a reliable access alternative for patients requiring chronic hemodialysis. Am Surg 1999;65:1038-42.
20. Puskar D, Pasini J, Savic I, Bedalov G, Sonicki Z. Survival of primary arteriovenous fistula in 463 patients on chronic hemodialysis. Croatian Med J 2002;43:306-11.
21. Kherlakian GM, Roedersheimer LR, Arbaugh JJ, Newmark KJ, King LR. Comparison of autogenous fistula versus expanded polytetrafluoroethylene graft fistula for angioaccess in hemodialysis. Am J Surg 1986;152:238-43.
22. Rayner HC, Pisoni RL, Gillespie BW, Goodkin DA, Akiba T, Akizawa T, et al. Creation, cannulation and survival of arteriovenous fistulae: data from the Dialysis Outcomes and Practice Patterns Study. Kidney Int 2003;63:323-30.
23. Allon M, Lockhart ME, Lilly RZ, Gallichio MH, Deierhoi MH, Young CJ, et al. Effect of preoperative sonographic mapping on vascular access outcomes in hemodialysis patients. Kidney Int 2001;60:2013-20.
24. Malik J, Slavikova M, Svobodova J, Tuka V. Regular ultrasonographic screening significantly prolongs patency of PTFE grafts. Kidney Int 2005;67:1554-8.
25. Lee T, Barker J, Allon M. Tunneled catheters in hemodialysis patients: reasons and subsequent outcomes. Am J Kidney Dis 2005;46:501-8.
26. Allon M, Daugirdas J, Depner TA, Greene T, Ornt D, Schwab SJ. Effect of change in vascular access on patient mortality in hemodialysis patients. Am J Kidney Dis 2006;47:469-77.

Submitted Mar 7, 2007; accepted Oct 4, 2007.

DISCUSSION

Dr Mellick T. Sykes (San Antonio, Tex). Dr Biuckians and his mentors in Norfolk are to be commended for this study, which analyzes a 6-month series of hemodialysis access creation in the KDOQI – Fistula First era. The specific focus is the natural history of autologous fistulas created as first-time hemodialysis access utilizing the National Kidney Foundation's DOQI guidelines.

The fate of these 80 study patients over the first postop year is grimly familiar to members of Southern Vascular. Summarizing the take-home points,

- "Early referral" is a myth, with 4/5 patients already on catheter dialysis before referral.
- Despite K/DOQI enthusiasm, at 1 year after fistula creation:
  - 40% (32/80) of fistulas have never been used – 25% (20/80) because they failed primarily (16) or after an intervention before use (4); 15% (12/80) because the patient died or found another solution although the fistula was patent.
  - 13% (10/80) were used at least once, but abandoned despite interventions
  - 48% (38/80) (less than half) were functional: (11% (9/80) worked w/o intervention – the "perfect" fistula; 37% (29/80) worked at the cost of 50 interventions in this subgroup, and 113 additional interventions in the original group of 80
- Maturation time was slow, interventions frequent, actual successful use the minority:

Is this the future? Is this the maintenance-free life that the KDOQI brochures depict? Have we bought swamp land in Florida? This does not seem intuitively different than the pre-KDOQI days?

The authors conclude that (1) successful AVF maturation is slower than previously reported, with a significant failure rate despite aggressive intervention; (2) that a new paradigm may be necessary; and (3) that KDOQI probably does not have the answer. But have they – or any of us – really read the KDOQI fine print?

I must say that I am not a huge fan of KDOQI:

- I resent directives from non-surgeons and nurses, who I picture sifting papers in a board room and directing surgical judgment from afar.
- I believe that KDOQI "scorecards" are unprofessional and embarrassing.
- I do not think that vein-at-any-cost is best for the patient, and take secret pleasure, if no forearm veins are evident, in placing a good old-fashioned loop graft like God intended.
- I believe that KDOQI has replaced the promiscuous use of prosthetic grafts by the equally promiscuous use of central catheters and percutaneous intervention – by radiologists, nephrologists, and vascular surgeons alike.

However, the KDOQI recommendations simply represent a classic and early example of the effect of evidence based medicine can and will have on our specialty.

We created it: Members of this Society were the vascular surgeons on the 2000 and 2006 work groups. KDOQI brochures quote our literature. They simply summarize what is available out there. If we believe we have a better vascular access mousetrap, we only need publish it. They cannot read our minds!

Moreover, no doubt with Alan Lumsden's help, the 2006 guidelines reflect common practice wisdom, and recognizes the problems noted in this paper: noting that "... the Work Group recognizes that in some cases, the "fistula first at all costs" approach may not be the most cost-effective or optimal for each individual. A functional fistula is the goal, not the insertion of a fistula with a poor chance at maturing. A graft can be used as a "planned bridge" to a fistula ..."[1]

Questions for the authors:

1. We have found open revision more lasting than endovascular interventions, particularly in peri-arterial stenosis. Could you comment?
2. How did this group compare with AVGs created at the same time?
3. What is your protocol for follow-up? Who followed the patient, and how? We now duplex fistulas monthly until use;
4. Who decided when to cannulate? When to intervene? When to abandon a site?
5. In particular, how do you explain the unusual delay in cannulation in your series? Were patients simply lost in the system?
6. Finally, what modifications do you recommend be made in the DOQI guidelines?

I commend the authors for a lucid presentation of this important data.

Dr Andre Biuckians. Thank you for those comments. In regards to your first question, a majority of the revisions performed were percutaneous but when we compared abandoned fistulas with functioning fistulas, functioning fistulas did receive some type of open revision more often. However, we did not analyze whether open or percutaneous interventions resulted in improved outcomes in this series. The practice prefers percutaneous interventions at the time of the diagnostic fistulogram and the fact that a majority of fistulas in the abandoned group received only a percutaneous intervention may be a reflection of unsalvageable fistulas rather than failed percutaneous interventions.

In regards to the comparison to first time grafts, we have submitted an abstract to the Society of Vascular Surgery's annual meeting this summer that summarizes the results, but I can give you a little snapshot. We found that the primary reason a patient received a graft as opposed to a fistula was due to inadequate vein size. When we looked at their patency in comparison, primary patency in the grafts was certainly worse, but secondary patency after intervention was better at 68% at 1 year. In addition, the number of interventions performed in the graft group was essentially identical to the number of interventions performed in the fistula group, and so we achieved better patency results with a similar intervention rate.

In terms of your question regarding follow-up, there is no protocol at this time. After surgery, patients are typically seen at 4-week intervals until the fistula is ready for use, so the surgeon is in charge of ensuring that these fistulas are maturing. We do not use duplex scanning on a regular basis and rather rely on clinical examination. If there is any question about whether the fistula will work, we will proceed with a fistulogram and intervene at that same setting.

And lastly, in regards to the NKF-DOQI recommendations, I think that the guidelines should focus on establishing any access that will be usable in a reasonable amount of time in order to decrease catheter dependence. It has been shown that catheter dependence carries significant risks and if we are trying to put fistulas in every patient in order to achieve a high level of autologous fistula use, in our experience, we are going to have a significant number of patients that are just waiting a long time with a catheter in place.

REFERENCE

1. http://www.kidney.org/professionals/KDOQI/guideline_upHD_PD_VA/va_guide2.htm

---

INVITED COMMENTARY

Thomas G. Lynch, MD, and **Troy J. Plumb, MD,** *Omaha, Neb*

In this series of patients receiving an initial, autogenous arteriovenous fistula (AVF), the reported primary patency at 1 year (36%) is low relative to other series. The authors attribute this to an aggressive approach to the placement of autogenous fistulas. In concluding, they note that adherence to the Kidney Disease Outcomes Quality Initiative (K/DOQI) strategy may not result in increased AVF utilization and may prolong catheter dependence.

While the manuscript describes their experience after publication of the K/DOQI guidelines, not all elements of the guidelines were followed. For the placement of an AVF to occur in a timely manner: (1) patients must have access to the healthcare system; (2) chronic kidney disease must be recognized by primary providers; (3) patients must be referred to nephrologists for pre-dialysis care; and (4) nephrologists must make timely referral for hemodialysis access assessment and placement. For the patients in this series, there was a breakdown in one or more of these elements, as 78% of those referred for placement of first time vascular access were already dialyzing via central venous catheters.

Once surgical referral occurs, K/DOQI emphasizes the importance of preoperative vein mapping, arterial assessment, and the preferred order of access placement to optimize the chance of maturing a functional fistula. Based on current literature and K/DOQI guidelines, arteries should be at least 2 mm and veins at least 2.5 mm, in diameter.[1,2] The order of preferred AVF placement is radiocephalic > brachiocephalic > brachiobasilic > arteriovenous grafts.[1]

The authors are to be commended for a critical review of their experience, which highlights opportunities for change that may ultimately impact long-term functional patency. The study indicates that there is, perhaps, a role for a unified approach to dialysis access. It is possible that patency may have been adversely impacted by the disparate approach of the 15 surgeons in this group and their lack of adherence to K/DOQI guidelines. Some of the surgeons proceeded directly to use of a prosthetic graft when patients were not candidates for radiocephalic or brachiocephalic fistulas, instead of attempting a brachiobasilic fistula. Only 76% of patients in this study underwent preoperative mapping. Despite mapping, veins with diameters as small as 1.3 mm were used for fistulas. Even after access had been placed, times to cannulation seem prolonged.

While we have a limited understanding of why fistulas fail, we do know that fistulas are more likely to fail when minimum requirements are not met. A standardized approach is crucial not only for clinical outcomes, but for our ability to study access outcomes. The goal is not to simply place an AVF, but to place an access that can be utilized for hemodialysis.

REFERENCES

1. National Kidney Foundation Kidney Disease Outcomes Quality Initiative Clinical Practice Guidelines and Clinical Practice Recommendations. Available at: http://www.kidney.org/PROFESSIONALS/kdoqi/guideline_upHD_PD_VA/va_guide1.htm. Accessed October 18, 2007.
2. Silva MB Jr, Hobson RW 2nd, Pappas PJ, Jamil Z, Araki CT, Goldberg MC, et al. A strategy for increasing use of autogenous hemodialysis access procedures: impact of preoperative noninvasive evaluation. J Vasc Surg 1998;27:302-7; discussion 307-8.